^{40}Ar/^{39}Ar Analyses of Orvinio (H6): Further Lessons on Incomplete Degassing of Impact Melt Breccias - Jennifer A. Grier, Timothy D. Swindle, and David A. Kring / Lunar and Planetary Laboratory, University of Arizona, Tucson, AZ, 85721.

While most L-chondrites have impact related ^{40}Ar/^{39}Ar ages that cluster around ~500 Ma [1] and 800 to 900 Ma [2,3], the distribution of impact ages among H-chondrite meteorites is much broader and does not seem to record any dominant thermal impact events (see table below). This may reflect: a different collisional evolution between the L-chondrite parent body(s) and H-chondrite parent body(s), a smaller fraction of H-chondrites are very highly shocked, or a statistical artifact because fewer H-chondrites have been analyzed with the ^{40}Ar/^{39}Ar technique, compared to L-chondrites.

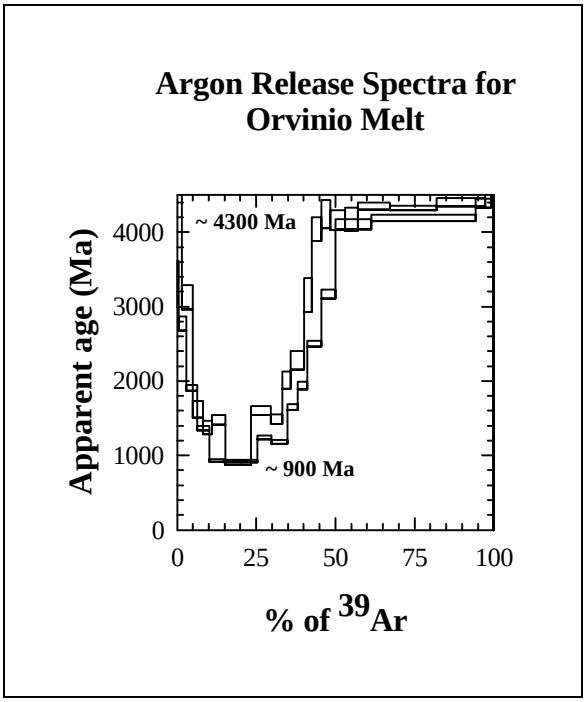
Impact Induced ^{40}Ar/^{39}Ar degassing ages in H-chondrites

Meteorite	Type	Age (Ga)
Clovis #2	H6	< 0.04
Ucera	H5	~ 0.04
Charsonville	H6	0.27 +/- 0.03
Sweetwater	H5	~ 0.29
Tulia	H	0.46 +/- 0.02
Jilin	H5	~ 0.5
Kimble County	H6	0.60 +/- 0.04
Dimmitt	H4	~ 0.9
Monroe	H4	~ 1.1
Plainview	H5 (clast)	3.63 +/- 0.07
Jilin	H5	3.95
Orvinio	(L6)H	Low: 0.8 High:1.9
Rose City	H6	Low: 0.38 High: 2.3

compiled from [1]

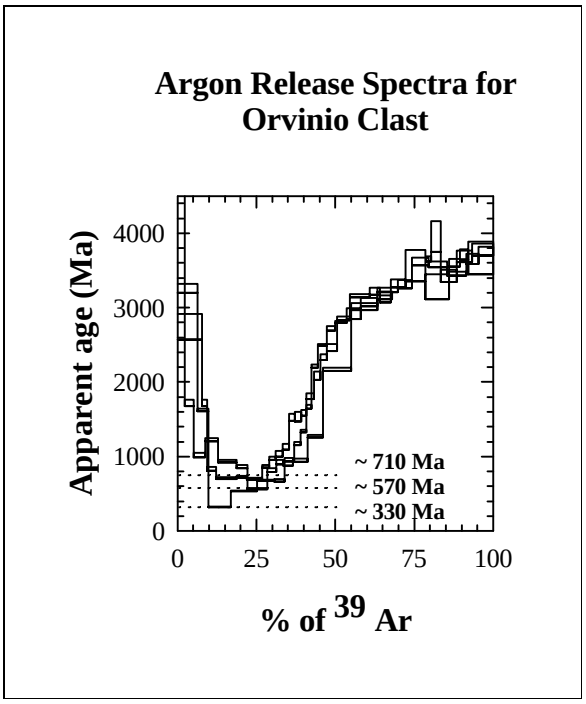
Orvinio is a classic impact melt breccia. Earlier analyses of a whole rock sample of this meteorite generated uncertain results, with a 800 - 900 Ma age as the lowest point achieved in the argon profile, with no plateau [4]. Previously listed as an L-chondrite, the spectrum was interpreted to represent partial degassing of the meteorite in the 500 Ma thermal event that affected many L-chondrites [4]. But Orvinio is an H-chondrite [5], and therefore its thermal history needs to be reinterpreted in this context. We obtained a new specimen of Orvinio and analyzed individual relic clasts and impact melt matrix samples in an attempt to provide improved ^{40}Ar/^{39}Ar age data, and perhaps eliminate the ambiguity in the thermal history of the meteorite. We hope to reach a better understanding of the use and interpretation of chondritic impact melt argon profiles, and of the history of the H-chondrite parent body(s).

Our preliminary results [3] of a single clast phase of Orvinio seemed to suggest that the ~900 Ma apparent age achieved in the lower temperature steps was "real" (i.e., reflected the actual timing of a thermal impact event, and was not a relic of incomplete degassing), since the clast phase had a mini-plateau at about 900 Ma, except for one step which dropped to 570 Ma, and this 900 Ma age matched the lowest point achieved in our melt sample.



We have subsequently brought the number of clast samples analyzed to three, and melt samples analyzed to two. The two samples of melt are superimposed (see figure, previous page). They show consistency in low points achieved (~900 Ma), shape, and in the plateau age reached in the higher temperature steps (~4300 Ma).

The clast samples, on the other hand, while having similar shapes to one another and reaching the same approximate ages in the higher temperature steps (no hint of plateau), are not consistent in the low points they achieve (see figure below). Two of the samples have one very low step at ~570 Ma and ~330 Ma, respectively, while a mini-plateau of three succeedingly higher temperature steps defines a ~710 Ma apparent age for one of the clast samples.



Consequently, a comparison of melt and clast data suggest the ~900 Ma age of the melt is likely an upper limit and not the true age of the major impact event. Also, the clast data, which achieves a minimum of ~330 Ma, suggest the impact occurred at or after this time.

Having lower ages in the clast material as opposed to the melt indicates some measure of incomplete degassing of the melt material during thermal events, not unlike what is seen in Peace River [6], and Chico [7]. The degree of degassing and successful resetting of the $^{40}Ar/^{39}Ar$ system probably depends on post-impact temperatures and cooling rates of the impact melt breccias. Peace River seems to represent an end member case, with its glassy (quickly cooled) melt containing a large amount of excess ^{40}Ar, and the clasts showing reasonably consistent plateau ages of 430 Ma [6]. Orvinio cooled relatively fast, ~5,000 to 40,000 $^{o}C/yr$ [8], which may explain why it is also incompletely degassed. In contrast, Chico, which is nearly completely degassed, had a cooling rate of 0.01 to 1 $^{o}C/yr$ [7], and Cat Mountain, which appears to be even further degassed, had a cooling rate of ~0.1 $^{o}C/yr$ [2]. Consequently, in contrast with the profiles for Peace River and Orvinio, the Cat Mountain $^{40}Ar/^{39}Ar$ degassing profiles for individual melt and clast samples all appear to be consistent with an 880 Ma age [2,9]. The melt phase achieves a good plateau in the low temperatures steps, and the clast samples analyzed have profiles with the same minimum age.

In comparing our Orvinio and Cat Mountain data, it is clear that the $^{40}Ar/^{39}Ar$ system is not reset in all impact melt breccias, and this confirms the need [7] to be careful when trying to determine the age of the thermal events that affected them.

References: [1] Bogard D. D., *Meteoritics* **30**, 224-268, 1995a. [2] Kring D. A., et al. *JGR* **101**, 29,353-29,371, 1996. [3] Grier, J.A. et al, *Meteoritics* **31,** A55, 1996. [4] Bogard D. D., and Hirsch, W. C. *GCA* **44**, 1667-1682, 1980. [5] Scott E. et al., *LPSC* **XVII,** 785-786, 1986. [6] McConville, et al., *GCA* **52**, 2487-2499, 1988. [7] Bogard D. D., et al., *GCA* **59**, 1383-1399, 1995b. [8] Smith B.A. and Goldstein, J. I., *GCA* **41**, 1061-1072, 1977. [9] Grier, J. A. et al., *LPSC* **XXV**, 475-476, 1994.